CONNECTION SYSTEM FOR CONNECTING~~THAT COUPLES AT LEAST ONE~~A FLAT BLOCK OF COMPONENTS TO ~~AT LEAST ONE~~AN APPARATUS

[0001] The present patent document is a continuation of PCT Application Serial Number PCT/EP2004/053725, filed December 29, 2004, designating the United States, which is hereby incorporated by reference and which claims priority to German Application No. 10 2004 005 545.9, filed February 4, 2004.

BACKGROUND

Field

[0002] The present ~~invention~~ embodiments ~~relates~~ relate to a connection system for connecting ~~at least one~~a contact of ~~at least one~~ a flat block of components to ~~at least one~~an apparatus~~.~~. ~~having the characteristics of the preamble to independent claim 1 and to a flat block of components having the characteristics of the preamble to independent claim 8 as well as to an apparatus having the characteristics of the preamble to independent claim 14.~~

~~**[0002]** Thus the present invention relates to a connection system for connecting at least one contact of at least one flat block of components to at least one apparatus, which system has a conductive connecting element, connected electrically conductively to the at least one contact of the flat block of components, and a clamping device connected electrically conductively to the apparatus, and the clamping device is embodied to receive the connecting element and thus, via the connecting element, to make an electrically conductive connection between the apparatus and the contact of the flat block of components. The invention thus furthermore pertains to a corresponding flat block of components and a corresponding contact.~~

Related Art

[0003] Conventionally, ~~A~~ a connection system ~~of this kind is typically realized by means of a~~has a cable ~~harness, so that typically the~~harness. A conductive connecting element ~~comprises~~ includes individual conductors of the cable harness ~~that~~, which are insulated from one another~~.~~. ~~When c~~The cable harnesses ~~are~~can be ~~used, it is~~a disadvantage~~ous~~ because there are multiple ~~that many~~ individual conductors that ~~have to be~~need to be connected, which increases~~. As a result, there is a great risk that individual conductors will be transposed, and as a result incorrect electrical~~ the possibility that there will be incorrect electrical connections ~~are made and~~ or short circuits ~~can be caused~~. Thus, there is a need for a simplified connection system.

SUMMARY

~~**[0004]** It is therefore the object of the present invention to make a connection system for connecting at least one contact of at least one flat block of components to at least one apparatus available in which the transposition of connecting elements can be reliably avoided, and the connection system generally has an especially simple, sturdy construction. It is a further object of the present invention to make a corresponding flat block of components and a corresponding apparatus available.~~

[0004] The present embodiments are directed to a connection system that couples a contact of a flat block of components to an apparatus, which may obviate one or more of the problems due to the limitations and disadvantages of the related art.

~~**[0005]** In a connection system having the characteristics of the preamble to claim 1, this object is attained by the characteristics of the body of independent claim 1. In the case of a flat block of components having the characteristics of the preamble to independent claim 8, this object is attained by the characteristics of the body of independent claim 8. In the case of a apparatus having the characteristics of~~

~~the preamble to independent claim 14, this object is attained by the characteristics of the body of independent claim 14.~~

[0005] ~~Thus t~~In a preferred embodiment, the connection system ~~of the invention for connecting~~that couples ~~at least one~~a contact of ~~at least one~~a flat block of components to ~~at least one~~an apparatus ~~has both~~comprises a conductive connecting element.~~,~~ ~~connected~~ The connecting element is electrically coupled to the ~~at least one~~ contact of the flat block of ~~components, and a~~components. A clamping device is ~~connected~~ electrically ~~conductively~~ coupled to the apparatus. The clamping device ~~is embodied to~~ receives the connecting element. Accordingly~~,~~ ~~and thus via~~ the connecting element ~~to make an~~ electrically ~~conductive connection between~~couples the apparatus and the contact of the flat block of components. ~~According to the invention~~

~~**[0006]**~~ In a preferred embodiment, the connecting element ~~connected~~ is ~~to the at least one contact of the flat block of components is embodied as~~ a rigid conductor, and the connecting element directly engages the clamping device of the apparatus~~,~~ ~~so that~~ Accordingly, the connecting element is ~~connected directly~~directly coupled to the clamping device. B

[0006] ~~B~~ecause the connecting element is ~~embodied as~~ a rigid conductor ~~connected~~ that is coupled to the flat block of components, confusing the conductor with another conductor is prevented, and thus ~~making~~ incorrect wiring is ~~precluded~~also prevented~~.~~. ~~Moreover~~In addition, plugs and ~~fastening material~~fasteners for the flat block of components ~~can be dispensed with~~are no longer needed.~~, since the flat block of components can be retained by the clamping device directly via the rigid conductor of the connecting element.~~ Because the connecting element engages the clamping device of the apparatus directly, a compact construction of the connection system is furthermore attained.

[0007] In a first embodiment, the flat block of components is a printed circuit board~~;~~. Tthe rigid conductor ~~forming the connecting element~~ is an ~~tongue~~

extension or tongue of the printed circuit board material.~~;~~ ~~and t~~The ~~at least one~~ contact is a conductor track disposed on the ~~tongue~~ extension of the printed circuit board material. In this ~~preferred~~ embodiment, no additional components are needed to furnish the connecting element. ~~element, no additional component is accordingly needed, making the connection system of the invention extremely economical~~.

~~[0009]~~ In a second ~~preferred~~ embodiment ~~of the present invention~~, the rigid conductor ~~forming the connecting element~~ is a metal bolt, which is ~~fastened~~ electrically fastened ~~conductively~~ directly to the contact of the flat block of ~~components.In a third, particularly preferred embodiment of the present invention,~~components.~~.~~ Alternatively, the rigid conductor ~~forming the connecting element~~ is a screw ~~fastened~~ electrically fastened ~~conductively~~ directly to the contact of the flat block of components.

~~[0009]~~ ~~[0008]~~ In this ~~case~~preferred embodiment, ~~it is especially advantageous if~~ the screw has a head~~, the screw, with~~ and a shaft comprising a thread. The shaft ~~having a thread, penetrates~~ is disposed in a bore ~~made~~ in the flat block of components in the region of the contact.~~,~~ ~~and t~~The screw is locked via a nut on a second side of the flat block of components, which is ~~diametrically~~ opposite a first side of the flat block of components.

~~Such a construction has especially great stability.~~

~~[0010]~~ ~~[0009]~~ In ~~the~~ a third~~, particularly preferred~~ embodiment ~~of the present invention~~, ~~it is also advantageous if~~ the head of the screw ~~comes into~~is electrically coupled ~~electrical contact~~ with the contact on the first side of the flat block of components.~~,~~ ~~and/or t~~ The nut of the screw ~~comes into electrical contact~~is electrically coupled with the contact on the second side of the flat block of components~~, because in this way an electrical connection between the contact and the connecting element can be established especially easily.~~. Accordingly, t~~T~~he contact and the connecting element are electrically coupled.

~~[0011]~~ ~~[0010]~~ In another ~~preferred~~ embodiment, ~~For further improvement of the electrical contact or for easier installation of the screw and nut, it can furthermore be advantageous if~~ the head and~~/or~~ the nut of the screw ~~is~~ are soldered or welded to the contact. Alternatively, the head or the nut of the screw is soldered or welded to the contact.

~~[0012]~~ ~~[0011]~~ ~~In the first, second or third embodiment of the present invention, it is advantageous if~~In a preferred embodiment, the flat block of components is an assembled printed circuit board. ~~In this case~~For example, ~~preferably~~ the inverter is ~~one or more~~at least one rectifiers~~.~~. ~~for one or more inverters of a magnetic resonance gradient amplifier are disposed on the printed circuit board and~~ The inverter ~~are~~ is connected to ~~one or more associated~~the apparatuses via ~~one or more~~the connecting elements and ~~one or more~~the clamping devices.

~~[0013]~~ ~~[0012]~~ In another exemplary embodiment, ~~In general, it is advantageous if~~ the ~~at least one~~ clamping device ~~of the at least one apparatus~~ is ~~furnished~~ directly ~~on~~ coupled to the ~~at least one~~ apparatus ~~or~~. Alternatively, the clamping device of the apparatus is coupled to the apparatus via ~~one or more separate~~ a securing robots that is ~~electrically connected~~electrically coupled to the apparatus~~.~~. ~~In that case, it is advantageous if a plurality of~~If a plurality of securing robots are used in a preferred embodiment, it is advantageous to have the securing robots ~~are~~ disposed in a row on a distributor busbar.

~~[0014]~~ ~~[0013]~~ ~~If~~ When the connection system ~~of the invention is to be embodied for connecting many~~ couples a plurality of contacts of the ~~at least one~~ flat block of components to ~~many~~ a plurality of clamping devices of the ~~at least one~~ apparatus, ~~it is necessary that~~ the plurality of the connecting element~~s~~ are ~~be~~ disposed in accordance with the disposition of the clamping devices on the ~~at least one~~ flat block of components.

~~[0015]~~ ~~[0014]~~ ~~The~~In the preferred embodiments, the connection system ~~of the invention~~ is ~~preferably~~ suitable for ~~the situation in which the~~ the apparatus. For example, the connection system is suitable for an apparatus, which is a transformer for a potential-free supply voltage for full bridge inverters of a magnetic resonance gradient amplifier.

~~[0016]~~ ~~[0015]~~ In another embodiment, ~~To furnish a disconnectable connection between the connecting element and the clamping device, it is advantageous if~~ the ~~at least one~~ clamping device is a screw terminal or a spring clip. For example, the connection between the at least one connecting element and the at least one clamping device can be disconnected.

~~[0017]~~ ~~[0016]~~ ~~Preferably,~~In a preferred ~~embodiment~~embodiment, the connection system is suited ~~for conducting~~to conduct voltages of over 24 volts~~,~~. In another preferred embodiment, the connection system is suited to conduct voltages~~preferably~~ over 120 volts, and ~~especially~~ even more preferably over 240 volts. In a preferred embodiment, the connection system is suited to conduct ~~and/or~~ currents ~~of~~ over 0.5 ~~ampere~~amperes.~~,~~ In another preferred embodiment, the connection system is suited to conduct current~~preferably~~ over 1 ampere, and ~~especially~~ even more preferably over 10 amperes.

~~[0018]~~ ~~[0017]~~ In the ensuing detailed description, the ~~present invention~~preferred embodiments will be described in terms of one exemplary embodiment in conjunction with the accompanying drawings. In the drawings, the same reference numerals identify the same elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Further advantages, characteristics and details will become apparent from the ensuing exemplary embodiments and from the drawings. In the drawings:

~~[0020]~~ ~~[0019]~~ Figure 1 schematically shows one exemplary embodiment of the connection system ~~of the invention~~; and

~~[0021] [0020]~~ Fig~~.~~ure 1' shows a top view of a rigid connector of ~~an alternative view on a detail of~~ the connection system ~~of the invention~~ of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

~~[0022] [0021]~~ In Figs. 1 and 1', the connection system of the invention is explained, for example, in the context of use with magnetic resonance gradient amplifiers.

~~[0023] [0022]~~ The connection system ~~of the invention~~ serves to connect contacts 1a, 1b, 1c, 1d, 1e, 1f, and 1g of rectifiers (the rectifiers are not shown in Figure~~.~~ 1) disposed on a printed circuit board 2 to transformers 3a, 3b, and 3c ~~for furnishing~~, which furnish a potential-free supply voltage for full bridge inverters, connected to the rectifiers, of a magnetic resonance gradient amplifier. The rectifiers together with the printed circuit board 2 ~~thus forms~~form a flat block of components.

~~[0024] [0023]~~ The inputs of the rectifiers are ~~untangled by~~coupled to conductor tracks (not shown) disposed on the printed circuit board 2. ~~in such a way that t~~The contacts 1a, 1b, 1c, 1d, 1e, 1f, and 1g of the inputs of the rectifiers are disposed on the printed circuit board 2 in accordance with the disposition of clamping devices 5a, 5b, 5c, 5d, 5e, 5f, and 5g of the transformers 3a, 3b, and 3c.

~~[0025] [0024]~~ In Fig. 1, the transformer 3a has three clamping devices 5a, 5b, and 5c, each with ~~one~~ a screw terminal~~.~~. The transformer 3b has three clamping devices 5d, 5e, and 5f, each with ~~one~~ a spring clip. The transformer 3c ~~has a connection to~~is coupled to both a screw terminal 5g and a spring clip 5h.

~~[0026] [0025]~~ As shown in Fig. 1', in a first embodiment ~~of the present invention~~, ~~some~~ a portion of the printed circuit board material ~~forming~~, which forms the printed circuit board 2, ~~forms a tongue on which~~ has a contact 1g ~~is disposed.~~. ~~, so that the overall result is~~The contact 1g is a rigid conductor. ~~as a~~The contact 1g is a connecting element 4g ~~for connection of~~that connects to the transformer 3c, via

the screw terminal 5g and the spring clip 5h. As shown in Figure~~.~~ 1, the transformer 3c is embodied, by means of the clamping devices 5g and 5h, to receive at least one part of the tongue 4g, carrying the contact 1g, in order to furnish a direct electrical contact with the rectifiers disposed on the printed circuit boards 2. ~~It is understood that for that purpose~~ In this embodiment, ~~,~~the clamping devices 5g and/or 5h ~~must be~~are connected to the electronic components of the transformer 5c and the rectifiers disposed on the printed circuit boards 2.

~~[0027]~~ **[0026]** In another~~a second~~ embodiment ~~of the present invention~~, ~~for making electrical connections with the transformer 3a on the printed circuit board 2, three~~ screws 4a, 4b, and 4c are secured directly to the corresponding contacts 1a, 1b, and 1c of the printed circuit board 2. The screws 4a, 4b, and 4c each have a head 6a, 6b, and 6c, respectively, and ~~with~~ a shaft 8a, 8b, and 8c. The shaft 8a, 8b, and 8c ~~they~~ penetrates the bores 9a, 9b, and 9c, which are made in the printed circuit board 2 in the region of the contacts 1a, 1b and 1c. The shafts 8a, 8b, and 8c are electrically coupled to the bores 9a, 9b, and 9c. On a second side 11 of the printed circuit board 2, which is diametrically opposite the heads 6a, 6b, and 6c of the screws 4a, 4b, and 4c, the screws 4a, 4b, and 4c, are locked by nuts 7a, 7b, and 7c. As can be seen in Fig~~.~~ure 1, the contacts 1a, 1b, and 1c are ~~through-contacted~~disposed through the bore 9a, 9b, and 9c from ~~the~~ a first side 10 oriented toward the heads 6a, 6b, and 6c of the screws 4a, 4b, and 4c to the second side 11~~.~~ ~~. oriented toward the nuts 7a, 7b, 7c of the screws 4a, 4b, 4c, so that both the~~Accordingly, the head 6a, 6b, and 6c ~~of the screws~~ and the nuts 7a, 7b, and 7c and the shaft 8a, 8b, and 8c of the screws 4a, 4b, and 4c ~~come into electrical contact with the~~are electrically coupled to the contacts 1a, 1b~~,~~, and 1c of the printed circuit board 2.

~~[0031]~~ **[0027]** In a preferred embodiment, ~~To simplify assembly and to improve the electrical contact,~~ the head 6b and the nut 7c of the screws 4b and 4c, respectively, are soldered to the contacts 1b and 1c of the printed circuit board 2.

~~To securely prevent loosening of the screws and to further improve the electrical contact, it is also possible,~~ In another preferred embodiment, ~~as is shown for the screw 4a, for~~ both the head 6a and the nut 7a ~~to be~~are soldered to the respective contact 1a. ~~Thus~~ Accordingly, the screws 4a, 4b, and 4c are electrically connected or coupled to the contacts 1a, 1b, and 1c of the printed circuit board 2 ~~form~~ by rigid connecting elements.

~~[0033]~~ **[0028]** The screw terminals 5a, 5b, and 5c of the associated transformer 3a ~~are embodied such that they at least partly~~ receive the screws 4a, 4b, and 4c. ~~and via the~~The screws 4a, 4b, and 4c ~~can make an electrical connection between~~electrically couple the transformer 3a and the respective contact 1a, 1b, and 1c of the printed circuit board 2. ~~Both the screws 4a, 4b, and 4c and the screw terminals 5a, 5b, and 5c are embodied such that the~~ The screws 4a, 4b, and 4c directly ~~and immediately~~ engage the screw terminals 5a, 5b, and 5c of the transformer 3a. Accordingly, the transformer 3a ~~and can thus be~~is ~~connected~~ directly and immediately coupled to the screw terminals 5a, 5b, and 5c.

~~[0036]~~ **[0029]** In ~~a third embodiment~~an alternate embodiment, the transformer 3b~~, instead of screw terminals,~~ has ~~three~~ spring clips 5d, 5e, and 5f ~~,~~instead of screw terminals. The contacts 1d, 1e, and 1f of the rectifiers associated with the transformer 3b are disposed on only one side of the printed circuit board 2. ~~For connecting t~~The contact 1d is electrically coupled to the associated spring clip 5d of the transformer 3b~~,~~ ~~,~~ aA metal bolt 4d ~~,~~ is electrically secured ~~electrically conductively~~ by soldering ~~directly~~ the metal bolt 4d directly to the contact 1d of the printed circuit board 2. ~~,~~The associated spring clip 5d ~~is embodied accordingly for directly receiving~~ receives and electrically ~~contacting~~ contacts the metal bolt 4d.

~~[0037]~~ **[0030]** The screws 4e and 4f differ from the screws 4b and 4c only in that they are not soldered to the associated contacts 1e and 1f, respectively.

~~[0038]~~ **[0031]** In another embodiment, ~~T~~the spring clips 5e and 5f ~~are also embodied for receiving and thus directly and immediately electrically~~are electrically

coupled to ~~contacting~~ the associated screws 4e and 4f, which directly engage the spring clips 5e and 5f.~~,~~ ~~so that via the screws 4e and 4f they will make an electrical connection between t~~The transformer 3b is electrically coupled to ~~and~~ the contacts 1e and 1f.

~~[0039] [0032]~~ ~~Since i~~In the connection system of the ~~invention~~ preferred embodiments, ~~the~~an electrical connection is made via rigid conductors, such as metal bolts, screws, or printed circuit board ~~tongues~~extensions, and thus no separate mounts for the printed circuit board 2 are necessary~~, since they are carried directly by the transformers 3a, 3b, and 3c.~~. Mistakes in wiring can ~~furthermore thus~~ be ~~reliably~~ avoided.

~~[0040] [0033]~~ In an alternate embodiment, which is not ~~separately~~ shown, the elements 3a and 3b~~, instead of being transformers,~~ are securing robots, disposed in a row in a distributor busbar~~;~~. ~~by way of which a~~An electrical connection is ~~to be~~ made between an arbitrary electrical apparatus, connected to the securing robots, and contacts of the printed circuit board 2.

~~[0035] [0034]~~ While the invention has been described above by reference to various embodiments, it should be understood that many changes and modifications can be made without departing from the scope of the invention. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, that are intended to define the spirit and scope of this invention.

ABSTRACT

~~[0036]~~ A connection system that couples a contact of a flat block of components to an apparatus is provided. The connection system comprises a conductive connecting element electrically coupled to the contact of the flat block of components, and a clamping device electrically coupled to the apparatus. The clamping device receives the connecting element. The connecting element is a rigid conductor~~.~~. The rigid conductor is a screw fastened conductively to the contact. The screw penetrates a bore in the flat block of components and is locked by a nut on a second side of the flat block of components, which is opposite a first side of the flat block of components~~.~~. ~~The invention concerns a flat block of components and an apparatus, as well as a connection system for connecting at least one contact (1a, 1b, 1c, 1d, 1e, 1f, 1g) (at least one in number) of at least one flat block of components (2) to an apparatus (3a, 3b, 3c). One conductive connecting element (4a, 4b, 4c, 4d, 4e, 4f, 4g) is connected in electroconductive manner to said contact (1a, 1b, 1c, 1d, 1e, 1f, 1g) (at least one in number). A clamping device (5a, 5b, 5c, 5d, 5e, 5f, 5g, 5h) is connected in electroconductive manner to the apparatus (3a, 3b, 3c). Therefore, the clamping device (5a, 5b, 5c, 5d, 5e, 5f, 5g, 5h) is designed to produce an electrocoductive connection, between the apparatus (3a, 3b, 3c) and the contact (1a, 1b, 1c, 1d, 1e, 1f, 1g) of the flat block of components (2), via the connecting element (4a, 4b, 4c, 4d, 4e, 4f, 4g). The disadvantage of this type of connection systems lies in the fact that the connection is generally provided via cable bundles with a plurality of individual lines, which entails risks of connection faults and short-circuits. The invention is characterized in that this problem is solved by the fact that the connection element (4a, 4b, 4c, 4d, 4e, 4f, 4g) connected to the contact (1a, 1b, 1c, 1d, 1e, 1f, 1g) (at least one in number) is in the form of a more rigid conductor and that the connection element (4a, 4b, 4c, 4d, 4e, 4f, 4g) penetrates directly the clamping device element (5a, 5b, 5c, 5d, 5e, 5f, 5g, 5h) of the

~~apparatus (3a, 3b, 3c) and is thereby directly connected to the clamping device (5a, 5b, 5c, 5d, 5e, 5f, 5g, 5h).~~